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ABSTRACT

A study examined the effect of word processing on the amount and kind of planning writers do. Subjects, 10 experienced writers and 10 student writers, wrote essays with pen and paper, word processing alone, and a combination of word processing and pen and paper. All students were experienced with computers. The subjects' think-aloud protocols and planning notes were analyzed. Results indicated that: (1) there was less planning with word processing; (2) there was less conceptual planning and more sequential planning with word processing; (3) the effects of writing media were similar for both experienced and student writers; and (4) there were vast differences in how writers use word processing and pen and paper together. (Five tables of data are included and 62 references are attached.) (RS)

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How the Writing Medium Shapes the Writing Process:

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Most composition researchers and theorists have acknowledged the importance of planning in writing. Not only is planning the hallmark of the expert writer (Hayes & Flower, 1980), but planning may be what allows us to learn as we write: the movement between text and plan may be where "discovery" during writing takes place (Bereiter & Scardamalia, 1987c; Murray, 1984; Penrose, 1987).

Arguments about the importance or value of planning in writing hinge, of course, on what we say planning is, and writing researchers have defined planning in a number of related, but not identical, ways. Burtis and his colleagues (Burtis, Scardamalia, Bereiter, & Tetroe, 1983) use Hayes-Roth and Hayes-Roth's (1979) definition of *planning* ("the predetermination of a course of action aimed at achieving a goal") as their own starting point in studying planning in writing, although they acknowledge that plans for writing often take a low-level form, especially for children. Flower and Hayes describe planning as consisting of three subprocesses: generating, organizing, and goal-setting (Flower & Hayes, 1981a; Hayes & Flower, 1980). Elsewhere (Flower & Hayes,1981c), they distinguish "plans for what to say next" and rhetorical plans, or plans which take into account the reader and the author's purpose. There may be

higher concentrations of planning early in a writing task, but planning does occur throughout the writing process (Flower & Hayes, 1981a).

Both Matsuhashi (1981) and Flower and Hayes (1980) claim that plans can sometimes take the form of internalized and generalized scripts, or formulas, for what to do or say; at other times, plans can be fuzzy and not well articulated, almost akin to imagistic thinking (Flower and Hayes, 1984). The period before writers begin to write has been seen by some researchers as crucial planning time, and they have discovered that these "prewriting" periods vary for different writers and different writing tasks (Emig, 1971; Pianko, 1979). Others (Gould, 1981; Matsuhashi, 1981) have assumed that pauses during writing reflect the presence of planning. Despite slight variations in definition and approach, planning remains an important concept for theorists, researchers, and practitioners alike. In fact, three important recent works reviewing research on writing devote full or partial chapters to discussions of the role of planning in the composition of written text. (See Bereiter & Scardamalia, 1987b; Faigley, Cherry, Jolliffe, & Skinner, 1985; and Hillocks, 1986.)

The Importance of Planning

Why is planning so important for writers? Certainly one reason why planning is important in writing is that the conversational supports of face-to face speaking are removed, and writers cannot rely on the nods, questions, or puzzled expressions of their audience to help they clarify and elaborate their messages. (Burtis et al., 1983; Daiute, 1986). Writing does, however, have an advantage over most kinds of conversation: it can be more carefully planned. The indiscrete comment that offends our listener in a conversation might not have been made if we had planned the conversation more carefully, but one of the hazards of face-to-face encounters is that they cannot always be planned. Planning in writing, like planning more generally, can be valuable because it is reversible, accommodates novel and flexible approaches, and allows writers to make and correct mistakes in a plan rather than in a text (Hayes, 1987). In short, planning is a smart, efficient strategy in many problem-solving activities.

One reason for researchers' interest in planning is that better writers seem to plan more. Bereiter and Scardamalia (1987a) found that young writers are often unable to differentiate writing from planning: when told to plan they simply generate content, or even lines of text. The planning of the more mature, adult writers that Bereiter and Scardamalia studied, however, was almost four times as long (in number of words spoken in a think-aloud protocol) than the text they produced from those plans. Flower and Hayes (1980) found expert writers differed from novice writers in both the amount and the kind of planning they did during writing.

Further, planning--especially planning beyond content retrieval--may increase and develop over the school-age years. Burtis and his colleagues (1983) found that ten-year olds exhibited virtually no organizational, reader-based, or goal-directed planning, but that for eighteen-year olds, these kinds of plans accounted for 13% of protocol statements during writing. In fact, the performance of their eighteen-year olds resembled the planning behavior of the experts studied by Hayes and Flower (1980). It may be that planning requires a level of metacognitive control which is beyond the capabilities of children (Bracewell, 1983), but that with some external supports or prompts--such as Scardamalia and Bereiter's "procedural facilitation" or "concretizing of goals" (1985)--children's planning abilities increase.

Planning occurs throughout the writing process (Flower & Hayes, 1981b). However, "prewriting" periods may be particularly important if, as some researchers assume, these are periods of invention, discovery, and planning (Rohman, 1965). Emig (1971) made a strong case for the importance of this prewriting period, claiming that during prewriting periods of her subject, Lynn, most of the major ideas and elements of the text were generated. Bereiter and Scardamalia (1987a) found that "start-up times" for fifth graders were much briefer than the start-up times of more experienced adult writers. Further, the students' start-up times did not change when they were given different kinds of writing tasks, or longer or shorter periods of time to write. Bereiter and Scardamalia take this as evidence for the existence of a knowledge-telling model for written composition in the younger writers.

Finally, some kinds of planning appear to be more valuable than others. Bereiter and Scardamalia (1987c) see a special value to planning which takes writers back and forth between content and rhetorical problem spaces. Flower and Hayes (1981b, 1981c) found that expert writers often made rhetorical plans--plans which took into account audience, context, and purpose--but that these kinds of plans were seldom made by novice writers. Types of planning are often set in contrastive terms: Bereiter and Scardamalia's knowledge-telling and knowledge-transforming (1987a) are similar to Flower and Hayes' (1981b) product-based and reader-based planning, both in the focus of each type of planning and in how each type is used by different writers: novices tend to rely on the former in each contrastive pair, while experts use the latter as well.

Not only are there distinctions between textual planning and rhetorical planning, but there may be differences between kinds of textual planning. Perl (1979) identified three different kinds of text-based planning strategies in her study of prewriting: rephrase the topic, free associate on all or part of the topic, and divide the topic into more manageable smaller subtopics. Matsuhashi's (1981) study of planning during pausing distinguishes between global and sentence-level text planning and her revision study (1987) sought to classify text revisions on the basis of the changed plans--conceptual or sequential--behind the revisions, rather than the changed words themselves. Burtis et al. (1983) claim that textual planning gradually becomes distinguished from text production during the course of writing development, and they distinguish between two types of planning for a composition: conceptual planning and content generation.

Factors Influencing Planning

Clearly, amount and kind of planning during writing may be partly a function of the writer's development (Burtis et al., 1983) or the writer's expertise (Flower and Hayes, 1981b). But several other factors seem to influence planning as well. Production factors, such as speed and mechanical constraints, may focus attention away from planning (Gould, 1980; Scardamalia, Bereiter, & Goelman, 1982). However, planning time (measured as pauses) seems to remain

constant, whether subjects are writing, speaking, or dictating (Gould, 1980). Burtis, Scardamalia, Bereiter, and Tetroe (1983) designed instruction to help focus immature writers' attention on conceptual planning, but they found that the students circumvented the researchers' purposes and used the prompts to generate content, or "knowledge tell." Another factor influencing both kind and amount of planning is a writer's knowledge. This may also help explain why students use conceptual planning prompts to generate content: younger writers' topic knowledge may be limited (Bereiter & Scardamalia, 1982).

The situation in which writing occurs may have an influence on planning as well. Many school writing situations may be so impoverished that students see no need or reason to plan (Applebee, 1986), or the structure of the school situation may in fact allow students to circumvent instructional goals and engage in less difficult writing tasks which don't require high-level planning (Doyle, 1983). Other, richer situations may allow writers to tap the rhetorical complexities of a situation and engage in more planning. For instance, students who watched a video tape of the audience for whom they were trying to write instructions, included more essential elements in their compositions than did students who were not exposed to the audience (Scardamalia, Bereiter, & MacDonald, 1977). Further, Berkenkotter (1981) found that skilled adult writers who were publishing members of academic disciplines created rich representations of both audience and context when they were writing about their discipline to high school students.

In addition, the specific writing task that writers face can exert a powerful influence on planning. For instance, with tasks which are very short--or must be completed very quickly--adult writers may cut short initial planning, or have shorter "start up times," according to Zbrodoff (quoted by Bereiter & Scardamalia, 1987a). Interestingly, children may not have the metacognitive control to adapt their planning to time and length constraints, as their start up times remained constant. Similarly, the kind of discourse that writers are producing can also lead to important differences in planning. Generalizing tasks and persuading tasks may require and elicit more planning than

does reporting of events. Matsuhashi (1981), studying the pause times of writers, found that when writing to generalizing or persuading tasks, subjects paused (and planned) more at both a syntactic and a discourse level than when they were reporting events.

Predictions about the Effect of Word Processing on Planning

The media that writers use may also influence their planning for writing. Specifically, the use of word processing or computers for writing may affect the amount of planning which occurs before and during writing. Daiute (1983) claims that using word processing may increase planning since writers--elementary school students particularly--can turn their attention away from handwriting, recopying, and checking spelling and focus on more higher level concerns. Collier (1983) makes a similar claim, saying that the large memory stores of computers and the ease of changes with word processing could "supplement rather than strain writers' conceptualizing powers" (presumably including planning). However, there are other research trends that suggest that this might not be the case--that writers may actually plan *less* when using word processing.

First, in marked contrast to Daiute's claims about elementary school children, many college student writers and adult writers report a tendency to work at a local level when using word processing. College student writers' revisions with word processing may tend to cluster at the word and sentence level (Collier, 1983). Student users of word processing may also spend a great deal of time trying out various ways of formatting their texts or testing various word- and sentence-level options (Bridwell, Sirc, & Brooke, 1985), although it is not clear whether students are aware that they are doing this.

Adult writers, at least, seem to be aware of the tendency to focus at a local level when using word processing. A survey conducted among faculty members at UCLA (Case, 1985) revealed that some faculty who used word processing felt that computers allowed writers to "fool around too much." Other experienced writers say that when using word processing "I keep tidying up,

tidying up" (Bridwell, Johnson, & Brehe, 1987). The fact that texts generated with word processing often *look* polished and finished may discourage further planning or revising. Concern with word-level changes or appearance may inhibit consideration of larger elements of discourse, including planning.

A second reason why word processing may inhibit planning has to do with how text is displayed. Faigley, Cherry, Jolliffe, and Skinner (1985) note the importance of rereading as a planning strategy, yet many studies of computer reading have shown reading on-line to be slower and often less accurate (Gould & Grischkowsky, 1984; Haas & Hayes, 1986; Heppner, Anderson, Farstrup & Weiderman, 1985). Further, computer screens typically display less text than a writer can see when using pen and paper. Writers are inhibited by not being able to reread their texts (without scrolling or paging), particularly for complex tasks such as persuasive writing (Britton, Burgess, Martin, McLeod, & Rosen, 1975). Poorer student writers may be more troubled by not being able to reread than average student writers (Hull, Arnowitz, & Smith, 1981). The relationship between reading and planning, and the inhibiting effect of word processing, are manifested in many experienced computer writers problems "getting a sense of their texts" when using word processing (Haas & Hayes, 1986). While this phenomenon may be a function of screen size and a difficulty in rereading, it may also be caused by writers' decreased planning (in a sense "rehearsing") of their texts when word processing.

Third, planning may decrease with word processing because planning notes may be difficult to create and manipulate when using word processing. Burtis, Scardamalia, Bereiter, and Tetroe (1983) found that planning notes were used by experienced writers to keep themselves on task, to keep track of their goals, and to explore ideas. In a word processing environment which does not allow or support note-taking, this important planning strategy may be circumvented. Burtis and his colleagues point out that many of the instructional procedures developed to help students enhance their planning are non-linear and diagrammatic. But many word processing systems do not allow for the creation of arrows, boxes, or other diagrammatic devices for

displaying conceptual relationships among notes.

Fourth, the anecdotal reports of experienced writers who used word processing suggest an awareness on their part that planning may be cut short when using word processing. Bridwell, Johnson and Brehe (1987) interviewed and observed a group of experienced writers using pen and paper and using word processing and found that many of the writers used pen and paper to plan when using word processing. Writers who made diagrams with pen and paper found it frustrating to not be able to do this on-line and one writer said he felt pressure to produce a text: there was "less sitting back and staring." A writer studied by Haas (1987) echoed this idea: he said that when using word processing "I don't feel I can just sit and think with my hands on the keyboard--I feel like I have to start typing" (p. 10).

Not only may amount of planning be affected by word processing, but there are reasons to believe that the use of word processing for writing may also influence the level, or type of planning that writers engage in. First, we might expect writers to do **more** word- and sentence-level planning (i.e., concerns of word choice, sentence structure, punctuation and other surface-level options) when using word processing than when using pen and paper. As discussed above, writers often report that when using word processing, they spend a lot of time on word- and sentence-level concerns because the technology makes it so easy to make these kinds of changes (Bridwell, Johnson, & Brehe, 1987; Case, 1985).

Contributing to the likelihood of more focus on low level concerns is the fact that when using word processing writers may be able to view less of their texts than they can when using pen and sheets of paper. Viewing only a portion of one's text might encourage writers to focus their attention on parts of text within a screen rather than think about concerns that extend across screens. Matsuhashi and Gordon (1985) hypothesized that student writers may see their texts as a "surface problem area," and therefore seldom move beyond the words on the page to higher-level concerns. Writing on a word processor--and seeing only a small part of their texts at once--might exacerbate this problem for student writers.

On the other hand, when using word processing writers might do **less** high-level text planning, that is, text planning concerned with text structure and organization, development of a thesis or argument, and choices about audience effect, the tone of the piece, or the writer's projected persona. The tendency to do less high-level planning might be particularly likely if there were in fact more low level planning with word processing. That is, if writers are devoting more attention to low-level planning with word processing, it is reasonable to expect that they might think less about high level text planning. Further, if note-taking on the word processor is inhibited, we might expect less high-level text planning since, as Burtis et al. (1983) point out, note-taking is used by writers to explore, develop, and organize ideas--all high-level text planning activities.

Only a handful of experimental studies have looked at the effects of using word processing on planning and the results have not been uniform or consistent. Gould's (1981) study of experienced writers looked at pause times as an indicator of planning and found that planning times were slightly longer for texts produced with word processing than for texts produced with pen and paper. Joram, Woodruff, Lindsay, and Bryson (1986) hypothesized that the ease of local changes and "subjects' compulsive editing" would interfere with the "production of creative ideas." Joram and her colleagues found that this was the case for more advanced student writers: they generated more ideas when they were not allowed to edit while composing on-line. However, basic writers tended to produce more ideas when they were allowed to edit during on-line composition. In a within-subjects protocol study of eight experienced writers, Haas (1987) found fewer total planning clauses and fewer initial planning clauses when the writers used word processing than when they used pen and paper.

Finally, few studies have compared different groups of writers' use of word processing. For instance, it is not clear whether using word processing would exacerbate or diminish differences in planning behavior between more and less skilled writers. Some studies (Hermann, 1987; Nichols, 1986; Woodruff, Lindsay, Bryson, & Joram, 1986) suggest that students of different skill

levels use word processing technology differently, but few studies have systematically compared expert and novice writers' behavior with word processing.

The impetus, then, for the current study came from these two directions. First, there is some reason to believe that word processing may repress or decrease planning and may also affect the kind of planning writers do. Second, the results of previous studies of this question have not been conclusive. The current study was driven by four research questions.

Do writers plan differently--in amount or in kind--when they are using word processing and when they are using pen and paper?

Does using pen and paper to supplement word processing change the amount or kind of planning?

Are there differences between experienced writers and student writers in how they plan when composing with pen and paper and with word processing?

Are there differences in extensiveness of planning notes generated with pen and paper and with word processing?

Procedure

Method

Researchers have used a variety of methods to study planning. Nelson and Hayes (1987) used process logs and interviews to study how students planned and carried out research papers. Gould (1981) and Matsuhashi (1981) collected pause times and assumed that pauses reflected planning. Matsuhashi (1986) also examined changes in written products and inferred the kinds of plans for revision that produced the changes in text.

In this study, we chose a think-aloud protocol methodology similar to that used by Hayes and

Flower (1980) because we believed that this methodology furnished a more complete picture of planning behavior than product or time measures. Participants were asked to speak aloud as they wrote. Those writers who had not encountered this think-aloud procedure were given a brief two-part training session in which they first saw the process modeled by the experimenter, and then practiced speaking aloud while a composing a short letter.

A mixed design was used, with one between-subjects factor (writing experience) and one within subjects factor (writing medium): 10 experienced writers and 10 student writers composed essays in each of three conditions. Audio tapes for each of the 20 writers' three sessions were transcribed and the resulting 60 protocols were parsed into clauses, following the general approach developed by Hayes and Flower (1980). Writers' planning notes were also analyzed. Then we examined differences in planning behavior between groups--experienced writers and college freshmen--and between word processing and pen and paper conditions.

Task and Design

This study employed a 2 x 3 factorial design: two groups of writers (experienced and student) composing in three conditions: pen and paper, word processing alone, and a combination of word processing with pen and paper (and hard copy printouts). Although previous research (Haas, 1987) had shown differences in planning when writers used pen and paper and when they used word processing, many writers who use word processing do so in conjunction with pen and paper (Bridwell, Johnson, & Brehe, 1987; Haas & Hayes, 1986). A condition that allowed the use of paper with word processing may more accurately represent the way many writers really use word processing. We refer to this condition as the "both" condition. In the two word processing conditions, writers were free to use a separate window for notes if they wished, and in the "both" condition they could use pen and paper for notes as well. In the pen and paper condition, writers had their choice of felt-tip or ball-point pen, and they wrote on eight and one-half by eleven inch white paper. The conditions were counterbalanced for topic and order.

Three topics were used similar to those developed and tested by Hoetker and Brossell (1986). The topics consisted of a class specification and two specifying criteria (e.g., "A book that many students read that may affect them in important ways."). The writers were free to specify the topic as they wished, based on their own experiences. The topics also allowed writers to either "explain" or "take a stand" about the subject they had chosen, and since all the subjects either were college students or worked on a college campus, the topics dealt with familiar school-related or academic experiences.

Following Hoetker and Brossell, we also cast the topic into a common syntactic pattern and tried to make the experimental situation reflect a real rhetorical situation. Therefore, writers were asked to participate in a "writing contest"--i.e., to write essays which were to be judged by actual readers on the basis of clearly stated criteria. As an added incentive, a cash "prize" was awarded to the contest winner in each subject group.

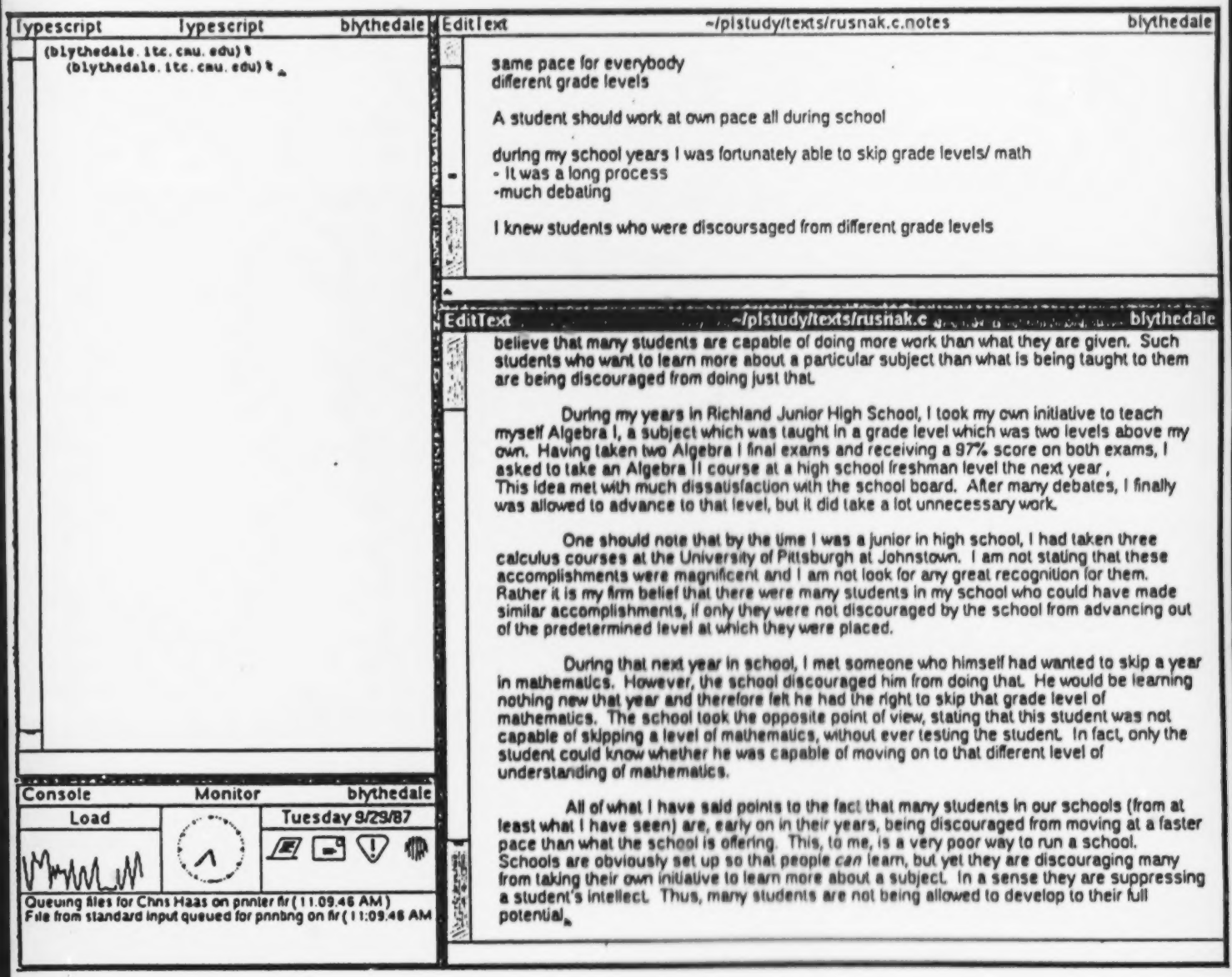
Participants

This study examined the planning behavior of two groups of writers--10 experienced writers and 10 student writers. The 10 student writers were all second-semester freshmen; they were randomly selected from a group of students who had completed two courses with Andrew (the computer system, described below, which was used for the study), one an introductory workshop and one a writing course using EditText, the text editor for the Andrew system. All students had passed this freshman-level writing course with at least a "B." The professions of the experienced writers included systems designers, teachers, and professional writers, and their ages ranged from 23 to 48, with a mean age of 29.7 years. These experienced writers were selected to participate based on two criteria: Andrew experience (daily use of the Andrew system for at least three months) and writing experience, established by having published technical or professional writing or by being recommended by their supervisors as better-than-average writers. Subjects were paid for their participation in the study.

All 20 of the participants were experienced with computers in general and the Andrew system in particular. The 10 experienced writers used the Andrew system in their daily work; eight of the ten had an Andrew workstation in their offices. They had been using computers or word processors on a regular basis for an average of 6.9 years, and they had been using the Andrew system and the text-editor EditText for an average of 1.9 years. The student writers had an average of 4.3 years computer experience and all had been using Andrew and EditText for two semesters. Many of the students had had their own computer at home during high school and over half knew one or more programming languages before coming to college. In short, all the participants were experienced and comfortable with computer technology.

The Word Processing System

The computing system used in this study was the Andrew system (Morris, Satyarayanan, Conner, Howard, Rosenthal, & Smith,1986), developed by IBM as a prototype educational computing system. The Andrew system and its text editor EditText offer a number of advantages for writers: a large, black-on-white display screen, approximately ten inches high and fourteen inches wide; a bit-mapped display for greater resolution; a mouse-and-menu driven interface, which lessens the necessity to remember commands; a scroll-bar for moving through the text and for indicating the relative length of the document; variable fonts (bold, italic, larger, etc.); a Preview program which shows writers a "picture" of how their finished document will look; and a windowing capability so that writers can view their document in one window and their notes or outline in another. Figure 1 shows the Andrew screen as it was set up by one of the student writers, with his notes in the upper window and his document in the lower window.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same pace for everybody
different grade levels
A student should work at own pace all during school
during my school years I was fortunately able to skip grade levels/ math
- It was a long process
-much debating
I knew students who were discoursaged from different grade levels
EditText ~/pistudy/texts/rusnak.c blythedale
believe that many students are capable of doing more work than what they are given. Such students who want to learn more about a particular subject than what is being taught to them are being discouraged from doing just that.
During my years in Richland Junior High School, I took my own initiative to teach myself Algebra I, a subject which was taught in a grade level which was two levels above my own. Having taken two Algebra I final exams and receiving a 97% score on both exams, I asked to take an Algebra II course at a high school freshman level the next year, This idea met with much dissatisfaction with the school board. After many debates, I finally was allowed to advance to that level, but it did take a lot unnecessary work.
One should note that by the time I was a junior in high school, I had taken three calculus courses at the University of Pittsburgh at Johnstown. I am not stating that these accomplishments were magnificent and I am not look for any great recognition for them. Rather it is my firm belief that there were many students in my school who could have made similar accomplishments, if only they were not discouraged by the school from advancing out of the predetermined level at which they were placed.
During that next year in school, I met someone who himself had wanted to skip a year in mathematics. However, the school discouraged him from doing that. He would be learning nothing new that year and therefore felt he had the right to skip that grade level of mathematics. The school took the opposite point of view, stating that this student was not capable of skipping a level of mathematics, without ever testing the student. In fact, only the student could know whether he was capable of moving on to that different level of understanding of mathematics.
All of what I have said points to the fact that many students in our schools (from at least what I have seen) are, early on in their years, being discouraged from moving at a faster pace than what the school is offering. This, to me, is a very poor way to run a school. Schools are obviously set up so that people *can* learn, but yet they are discouraging many from taking their own initiative to learn more about a subject. In a sense they are suppressing a student's intellect. Thus, many students are not being allowed to develop to their full potential.

Figure 1. Andrew Display with two editing windows.

While the word processing systems available to most educational institutions, and to most writers, are not as advanced as the Andrew system, we believed that using this technology for the study made sense for a number of reasons. First, using *any* word processing system for such a study is problematic; while it is important to control for word processing system and to clearly state the system used clearly, there is no one word processing system which would allow us to draw more generalizable results. Further, a careful description of the word processing system used can facilitate comparison among studies: even though a comprehensive study of all available word processing programs is not feasible, researchers can compare their results if the system variables are clearly laid out.

Second, the trend has been for computers to become cheaper and more readily available; more advanced computer systems, like Andrew, may soon be available to a much larger segment of the educational community. Certainly given the advantages for this advanced technology that we have seen--and expect to see--teachers might demand better technology for their student writers. These studies may furnish educators with needed information on the importance of investing in quality, advanced equipment.

Third, the planning problem may not in fact be a function of the type of machine people use. In a study of writers composing with Andrew, with an IBM-PC, and with pen and paper, Haas (1987) found that both computer systems seemed to limit planning.

Measuring Facility with Word Processing

A writer's facility or lack of facility with a particular word processing system may contribute significantly to differences in writing success and to differences in writing process behaviors. For instance, a writer who is unaccustomed to the software he or she is using may spend a great deal of cognitive effort trying to remember commands for moving through a document, or trying to recall how to cut and paste text. As writers attend more to the machine they are using

to write, it seems reasonable that they would attend less to the writing task itself. Under these conditions, the processes by which a text is produced could be altered.

The participants wrote regularly with the text editor used in the study; to further insure that writers were facile with the Andrew system, they each completed a pre-test of facility with EditText. The pre-test was based on a set of "bench mark" text editing tasks developed by Card, Moran, and Newell (1983). These tasks had the advantage of having been used in an evaluation-comparison of several kinds of text editors; further, the three sub-tasks we selected were ones that seemed crucial for producing an original document with word processing: typing, correcting errors, and moving chunks of text. The participants were first instructed to type a short 153-word letter. They were then given a copy of the letter with ten corrections and asked to make the corrections; the corrections included adding and deleting words, replacing capital letters, and changing the date. Finally, participants were asked to transpose two of the paragraphs of the letter and to cut and paste an additional paragraph from a separate file. Time data were collected for each of these three operations--typing, correcting, and moving.

All participants were able to complete the pre-test and there were no outlying scores. Time scores for all participants fell well within three standard deviations for their subject group. The mean times for typing were 4:42 minutes for experienced writers (34.4 mean words-per-minute) and 7:06 minutes for students (22.42 mean words-per-minute). The mean times to complete the ten corrections were 1 minute, 12 seconds for experienced writers and 1 minute, 56 seconds for students. The mean times for moving chunks of text were 1 minute, 20 seconds for experienced writers, and 1 minute, 55 seconds for students.

Analysis: Amount of Planning

Our first analysis sought to examine differences in amount of planning between groups and between conditions. Each clause in the protocols was coded as one of six major writing activities: planning, producing text, rereading text, evaluating text, attending to the medium, and

verbalizing commands (in the word processing conditions).

Planning. This was a broad category and included setting goals and making plans for what to do or say. Burtis's (Burtis et al.,1983) notion that planning is gradually differentiated from text production makes sense not only developmentally, but also in the context of real-time writing production; i.e., "planning" and "translating," or text production, can best be seen as a continuum, with abstract, high level plans for audience effect or topic at one end, and plans for word choice and syntax at the other. These very local word- and syntactic choices are only slightly differentiated from the production of words on the page or screen. Therefore, the category for planning comments was broad enough to incorporate the range of plans for text that writers use. The Burtis et al. study (1983) used a similarly broad coding scheme to account for all instances of planning in their analysis of children's planning. Their coding scheme, like the one used here, included a range of planning behaviors, from language considerations to organizational and content concerns, to considering audience and developing purpose. Our planning category also included the three sub-processes of planning--generating, organizing, and goal setting--identified by Hayes and Flower (1980).

Comments in the planning category ranged from very broad, such as deciding on a topic ("I guess I'll write on fraternities"), to very narrow, such as trying out various sentence-level or word level options. Other kinds of planning comments were procedural or process comments--"I'll make a note and come back to this later" or "Let's reread it"--and rhetorical planning comments, like "I'll try to convince them [audience] of my view" or "I want to sound reasonable." In this initial coding, we sought to include most of the kinds of planning--rhetorical, procedural, content-based--that other researchers have studied. The discussion below on coding for types of planning offers a more detailed description of the range of planning behaviors.

Producing Text. These comments were verbalizations of the text as it was being produced. Statements were coded whether or not they were included in the final text. Sometimes, in the

written transcript of the writing session, it was difficult to determine if word- and sentence-level comments were plans or if they were actually written down. In these cases of confusion, subjects' notes, drafts, and final texts were examined. In two instances, tapes of sessions were also used to clarify the nature of the comments.

Rereading. Statements in this category included subjects' rereading of their own texts. It did not include reading and rereading of the instructions, which were not coded.

Evaluating and Reviewing Text. This category includes comments in which the writer reviews or evaluates previously written text. Evaluative comments can range from very broad comments, such as "This is horrible" or "I like this" to more specific comments, like "I've spelled *tenure* wrong." Also included in this category are comments in which the writer reviews or sums up previously written material: "So I've covered points one and two [on her outline]," "I've talked about American schools, and I've talked about Japanese schools," "Now that paragraph sets up the problem."

Attending to the Medium. Comments in this category were direct reference to the tools being used (beyond a mere verbalization of command sequence; see below). These were comments in which the focus of attention moves from the writing task to the medium used to produce text. Some examples of comments coded into this category are "So I'm repositioning the window and moving it here to here," "This [the system] seems slow today," and "I need an eraser."

There were also two throw-away categories (described below) which were excluded from the analysis, issuing commands and extraneous comments. These two categories together accounted for from 3% to 16% of the protocols.

Issuing Commands. Verbalizations of commands as they were given were included in this category. These comments often occurred by themselves: "Cut," "Save," "Center." Commands were sometimes embedded in longer clauses, in which case they were usually coded into another category. For example, the clause "I'm going to cut this section," was coded

as planning rather than as the verbalization of a command. Issuing commands only occurred in the two word processing conditions and usually accounted for less than 5% of the protocols.

Extraneous Comments. There was also an extraneous category which included questions to the experimenter, comments irrelevant to the task at hand (for instance, about the weather or the coffee), statements about the procedure, and unintelligible comments.

A reliability check of this initial coding revealed 89% agreement between two raters and reliability of .85 by Cohen's kappa. The five major categories--planning, producing text, rereading, evaluating and reviewing, and attending to the medium--accounted for over 88% of the protocol statements. Excluded from further analysis were the protocols of one student writer, who exhibited no planning behavior at all. In each of her three writing sessions, this student read the topic, paused briefly, then began generating text--which she verbalized--in a steady stream with no pauses or comments beyond "Let's see" or "OK." This student, who was judged an excellent writer by her English teacher, appeared to have a well-articulated writing "script" (Flower & Hayes, 1980) which allowed her to generate a fairly coherent, if conventional, response to the topic.

Results: Amount of Planning

Total Planning

Our first analysis examined differences in total amount of planning for the two groups of writers, experienced writers and student writers, and three conditions, pen and paper, word processing alone, and word processing with pen and paper allowed (the "both" condition). The total number of protocol statements coded as planning were tallied for each writer in each condition; proportions were derived relative to the total number of clauses in each protocol.

We were primarily interested in proportion of planning in each condition--that is, the amount of planning relative to the total length of the writing session and of the protocol--since the length of

the writing session were quite varied among individuals and across groups; e.g., protocols ranged in length from 4 pages for one student writer to 16 pages for one experienced writer. Proportional analysis reduces the variance and shows the differences between conditions more clearly.

Means for proportion of planning, as shown in Table 1, were similar for the word processing and both conditions (27.2 and 27.8, respectively), but there was proportionately more planning in the pen and paper condition (33.9). A two-way analysis of variance for proportion of planning showed a main effect for condition [$F(2.34)=6.73$, $p < .005$], an effect for group that was just short of significant [$F(1, 17) = 2.98$, $p < .10$], and no interaction between group and condition [$F(2. 34)=.81$]. Neuman-Keuls analysis shows that this variance can be accounted for by a significant difference ($p < .001$) between the pen and paper condition and the word processing alone condition, and a significant difference ($p < .01$) between pen and paper and the "both" condition. The word processing alone condition and the word processing with paper allowed conditions both resulted in significantly less planning than the pen and paper condition, but there were no significant differences between these two word processing conditions.

Table 1
Mean Proportion of Planning Statements

	Pen and paper	Word Processing	Both
Experienced writers	38.5 (SD=12.0)	29.8 (SD=12.4)	32.6 (SD=13.9)
Student writers	28.8 (SD=10.4)	24.3 (SD=12.9)	22.4 (SD=7.2)
Combined	33.9	27.2	27.8

These analyses reveal important differences in the planning of the same writers using different media. A reasonable question at this point might be "Were there differences in when writers planned?" Although linear stage models of writing often place planning at the beginning of the writing process, we know from research that planning can go on throughout the composing process (Flower & Hayes, 1981). We wondered if writers using word processing were planning less throughout the composing process, or if there were instead specific points at which planning was repressed.

Initial Planning

Our next series of analyses examined initial planning, or the planning that occurred before writers produced a written sentence. This early period seen as crucial to writing success: during these initial planning periods, writers seem to generate and organize content, establish their purpose, consider their audience, and set the tone for the piece (Emig, 1971). However, writers who use word processing, like the university faculty interviewed by Case (1985), may feel that with the machine they develop material too quickly, without time for reflection.

We saw initial planning then, as a fruitful place to look explore further the differences in planning

between conditions. The number of planning statements before the generation of text were tallied for each writer in each condition and proportions were derived relative to the total amount of planning. In other words, we were interested in the proportion of planning in each condition that occurred before writers began to produce text. In the pen and paper condition, initial planning was the largest proportion of total planning (42.6), with the word processing condition and the "both" condition showing similar proportions of initial planning (28.3 and 31.8). Further, when the groups are broken out, we see that the experienced writers are doing more initial planning than are the student writers (as we would expect), although both groups have the most initial planning in the pen and paper condition and the least in the word processing alone condition. For experienced writers, the proportions were 48.4 in the pen and paper condition, 38.5 in the word processing condition, and 37.5 in the "both" condition. The proportions for student writers were 36.1 in the pen and paper condition, 25.4 in the "both" condition, and 17.0 in the word processing condition. (See Table 2.)

Table 2
Mean Proportions of Initial Planning

	Pen and paper	Word processing	Both
Experienced writers	48.4 (SD=22.0)	38.5 (SD=16.9)	37.5 (SD=20.5)
Student writers	36.1 (SD=23.8)	17.0 (SD=13.4)	25.4 (SD=20.5)
Combined	42.6	28.3	31.8

Results of a two-way analysis of variance for initial planning proportions showed a main effect for condition [$F(2,34) = 3.77$, $p < .03$], a main effect for group [$F(1.17) = 5.55$, $p < .03$], and no interaction [$F(2,34) = .48$]. Neuman-Keuls analysis revealed that this difference in proportions of

initial planning can be accounted for by a significant difference ($p < .05$) between the pen and paper condition and the word processing alone condition.

The "Both" Condition: Analysis and Results

One of the intriguing results we noticed after completing the analysis for total planning and initial planning, was the lack of significant results for the "both" condition. We had anticipated that the "both" condition would be very conducive to writers' planning because it would allow them to take advantage of both word processing and pen and paper; i.e., the speed of producing text could be retained via the word processor, but planning notes and outlines could still be done on pen and paper. Further, most of these writers reported that they typically produced texts in just this way--using pen and paper to supplement word processing.

However, the mean scores for this condition usually fell between those of the other two conditions. (See Tables 1 and 2.) Analyses of proportions of total planning and proportions of initial planning revealed no differences between the word processing alone and the "both" conditions. Therefore, while we expected that the "both" condition might favor planning, the results were inconclusive.

The way that people responded to the "both" condition may have contributed to the lack of significant results. Not all of the writers utilized both tools in the "both" condition: five of the ten experienced writers and three of the nine student writers treated the "both" condition as if it were a computer alone condition; they did not make any hard copy notes, nor did they generate a printout in the "both" condition. Therefore, the scores in this condition do not reflect the planning behavior of a group of writers using both pen and paper and word processing, but rather eleven writers using word processing alone and only eight writers using both pen and paper and word processing.

In order to determine if there were differences in planning between those writers who used pen

and paper in the "both" condition and those who did not, we divided each of the subject groups (experienced and student) into two sub-groups. This analysis contrasted writers in a "true" both condition to writers in what was in fact a word processing alone condition. Mann-Whitney tests showed no significant differences between writers who did and who did not use pen and paper to supplement word processing, either for total planning in the "both" condition, or for initial planning in the "both" condition [U=9; U=10]. Finally, an analysis was done on the numerical differences in planning proportion between the "both" condition and each of the other two conditions for each group of writers: those who had and those who had not used both media in the "both" condition. Again, Mann-Whitney tests revealed no differences [U=9].

Although many writers report using pen and paper to supplement word processing for planning notes or for initial writing (Bridwell-Bowles et al. 1987; Haas & Hayes, 1986), the writers in this study varied widely in whether and how they used pen and paper to supplement word processing. Consequently, the results of analyses of planning in the "both" condition are inconclusive.

Analysis: Kinds of Planning

It is important to determine if writers plan differently in kind as well as in amount when using word processing and pen and paper. We next explored the hypotheses suggested above, namely, 1) when using word processing, writers would do **more** word- and sentence-level or sequential planning, and 2) when using word processing alone, writers would do **less** whole text, or conceptual, planning. For these two analyses, we compared only pen and paper and word processing alone conditions, because previous analyses had suggested that the important differences lay here and because there were large individual differences in the way writers used the "both" condition. Although we were interested in text plans specifically, in order to account for each planning statement, we developed a four-category coding scheme. Each planning statement was sorted into one of four categories: process plans, rhetorical plans, conceptual text plans, and sequential text plans.

Process Plans. Process plans in the current study are similar to Flower and Hayes' (1981b) procedural plans: they often take the form of instructions the writers give themselves to keep on task. Comments were placed in this category if they were content-free and they tended to be rather generic. In this study, process planning comments were often cues to begin and end, decisions to reread, or decisions to delay a certain activity. Some examples of process planning comments are "I'll reread this," "Come back to this later," and "I guess I'll finish up."

Rhetorical Plans. When making rhetorical plans, the writer is concerned with the rhetorical situation surrounding the text he/she is creating. In rhetorical planning comments, the writer voices concern about the audience and their knowledge and beliefs, the writer's intended effect on that audience, and the writer's concern with his/her own persona or voice or "how I'm coming across." Some examples of rhetorical planning comments are "I want to convince them that this view is wrong," "How much do they [the audience] know about this? Probably not much," and "I don't want to sound like a bigot." Flower and Hayes (1981b, 1981c) found that rhetorical concerns like this were powerful planning moves for expert writers, but that novice writers seldom made rhetorical plans.

We expected that there would be differences between subjects and between groups in these planning categories, but that pen and paper or word processing conditions would not have an effect on process planning or rhetorical planning. Therefore, our analysis focused on plans for text.

Matsuhashi's (1987) analysis of different kinds of revision plans provided a useful way to begin to explore these hypotheses about the impact of word processing on different kinds of planning. Drawing on de Beaugrande's (1980) notions of Conceptual Connectivity, which deals with underlying conceptual relations, and Sequential Connectivity, which focuses on the lexical arrangement of the surface text, Matsuhashi developed a coding scheme to distinguish two kinds of text planning. Although she was using changes in a text to infer what kind of planning was occurring during pauses in revision--Conceptual Planning or Sequential Planning--

Matsuhashi's categories of planning were also useful for coding protocol statements. Her coding scheme was adapted slightly for this study and the names of her categories were retained.

Conceptual Plans. These plans guide the creation of the conceptual meaning and structure of the text. Generating content, exploring the topic, deciding "what to talk about," organizing ideas, elaborating and coming up with examples, developing ideas--all these are part of conceptual planning. This category subsumes the three subprocesses of planning outlined by Hayes and Flower (1980): generating, organizing, and goal setting. In this study conceptual planning often occurred in lengthy episodes, especially at the beginning of the writing session, as in this example.

> Let's see what could I write about....what habits did I develop in college? What about smoking...drinking..staying up late. Those are all bad habits. Do kids develop any good ones? I guess kids at [this university] probably do...

Other examples include "So now I need to get real specific," "What else could I say about this?" and "Let's see...I need to tie all this together in a concluding paragraph."

Sequential Plans. Sequential planning focuses on lexical or syntactic arrangement, or the textual expression of meaning. Decisions about word choice or syntactic arrangement as text is produced are the most common examples of this type of text planning. Many of the statements in this category resembled the "proposing and evaluating of sentence parts" identified by Kaufer, Hayes, and Flower (1986) in their analysis of the translating process. Many of the statements coded as Sequential Planning were interrogatives, questions like "What do I mean?" or "What do I want to say?" or simply "What?" interjected into verbalizations of the production of text on the page or on the screen (Kaufer, Hayes, & Flower, 1986).

Writers vary in how much they plan (or struggle) to produce text at the point of utterance. For some writers, every written phrase is preceded by elaborate word-level plans; for others, the words seem to flow off the pen (or off the keyboard) without much sequential planning. For some writers, this "struggle" to produce words may be where ideas are tried out or even

"discovered" (Murray, 1978). The following example shows the nature of these kinds of Sequential Planning statements. Text that was actually written is in italics.

> Partying can affect the student in...let's see. OK. *Partying*, partying provides the student with...what? When at college there are many...*When a students goes to college* he, he or she? no.. *he finds many more parties than before.*

Also included in this category are concerns with spelling and punctuation, and comments in which the writer refers to "last paragraph" or "next sentence" without any mention of the meaning or function of that paragraph or sentence. Some examples of sequential planning comments are "Should that be a semi-colon or a colon?" "Should I say students or kids?" and "I'll make this two paragraphs."

While the category of Conceptual Planning used here is quite similar to a category of planning with the same name developed by Burtis and his colleagues (1983), there is an important distinction between Sequential Plans and Burtis et al.'s counterpart to Conceptual Planning, "content generation." The product of content generation, they state, is language or content to be used in the text. Here, generation of content items would be included in Conceptual Planning; generation of language to express that content falls into the Sequential Planning category. The difference is not a large one, and is the result of a difference in focus: Burtis et al. were interested in young children's concern with content at the expense of other kinds of planning. The distinction between concerns about expression and language and concerns of generating and organizing the whole text makes more sense for the current study.

In essence, then, this coding scheme makes a distinction between "thought" or "meaning" and "language." While we realize that this distinction is a tenuous and largely theoretical one, we were able to distinguish the two types of planning comments with some regularity: agreement between two readers trained in the coding scheme for types of planning was 91% with a reliability of .76 by Cohen's kappa.

Results: Kinds of Planning

We conducted two separate analyses--one for sequential planning and one for conceptual planning. While these two phenomena could occur together (that is, writers could do less of one and more of the other), each could also occur independently.

Sequential Planning

Our analysis examined the amount of sequential planning as a proportion of total planning. As Table 3 shows, the amount of sequential planning was almost half again as much in the word processing condition as it was in the pen and paper condition (36.2 and 25.3, respectively). A two-way analysis of variance reveals no difference between groups in proportion of sequential planning [$F(1,17)=.42$], but a significant [$F(1, 17)=6.76$, $p<.01$] difference between conditions. There was no interaction [$F(1, 17)=.22$]. This analysis reveals that there was significantly more sequential planning when writers used word processing alone.

Table 3
Mean Proportion of Sequential Planning

	Pen and Paper	Word Processing
Experienced Writers	27.9 (SD=15.9)	39.6 (SD=17.9)
Student Writers	22.4 (SD=10.6)	35.4 (SD=13.1)
Combined	25.3	36.2

Conceptual Planning

Conceptual planning as a proportion of total planning was then analyzed. Conceptual planning accounted for a proportion of 67.7 of the total planning in the pen and paper condition and a proportion of 52.1 in the word processing condition. (See Table 4.) Two-way analysis of variance for proportion of conceptual planning shows a main effect [$F(1,17)=11.76$, $p<.003$] for condition, no effect for group, and no interaction.

Table 4
Mean Proportion of Conceptual Planning

	Pen and Paper	Word Processing
Experienced Writers	66.2 (SD=16.5)	53.7 (SD=16.3)
Student Writers	69.4 (SD=7.5)	50.2 (SD=18.1)
Combined	67.7	52.1

A subsequent analysis of the raw number of clauses of conceptual planning underscores the differences for conditions and shows a difference between groups. The mean number of conceptual planning statements was half again as much in the pen and paper condition as in the word processing condition (75.9 and 52.7, respectively). The patterns hold for each group, although the experienced writers had more conceptual planning statements than did the student writers. The mean for experienced writers was 105.3 statements in the pen and paper condition and 73.9 in the word processing condition, while the student writers' means were 43.2 conceptual planning statements in the pen and paper condition and 29.1 in the word processing condition. A two-way analysis of variance showed a main effect for condition [$F(1,17)=8.80$, a main effect for group [$F(1,17)=6.34$, $p<.05$], $p<.01$], and no interaction [$F(1, 17)=1.27$].

Planning Notes: Analysis and Results

Our final analysis examined the planning notes (e.g., outlines, lists, jottings, stars and arrows) produced by the writers in the three conditions. We were interested in these notes for several reasons. First, based on previous research (Burtis et al., 1983) we believed that the making of notes serves an important planning function, allowing writers to explore and organize ideas and keep themselves on task. Therefore, we expected that note-making would aid and possibly increase writers' planning. We expected writers who planned more would produce more planning notes and, more to the point for this study, that those conditions which allowed or encouraged note-making would evidence more planning. Specifically, we expected both less planning and fewer notes in the word processing alone condition.

A second hypothesis concerned the taking of notes in the word processing with paper allowed condition. We anticipated that one of the most important ways that writers would supplement word processing in this "both" condition would be to use pen and paper for notes--a behavior often reported by writers using word processing (Haas and Hayes, 1986; Bridwell-Bowles et al.,

1987).

The notes produced during the writing sessions of each writer were collected. Notes produced on-line were saved in a separate notes file. The number of words produced in each condition were tallied and totalled. We analyzed final notes only; i.e., since notes produced and then deleted on the word processor were not captured, we also did not count any crossed out or erased notes in the pen and paper condition.

It is interesting first to note in which conditions the writers took notes at all. More writers took notes in the pen and paper condition than in the other conditions. Of the 19 writers, two (one student and one more experienced writer) did not take notes in any of the conditions. In the pen and paper condition, all of the remaining 17 writers took notes. Ten writers took notes in the word processing condition only, and 13 writers took notes in the "both" condition. Table 5 shows the patterns of note-taking in the three conditions.

Table 5

Number of Writers Making Planning Notes in each Condition.

	with Pen and paper	with WP	with Both		
			Pen only	WP only	Both
Exp. Writers (n=10)	9	7	4	1	2
Students (n=9)	8	3	5	3	0
Total	17	10		13	

Not only did more writers take pen and paper notes, but the mean number of words of notes was highest in that condition, 69.26 words. The mean number of words of notes taken in the

"both" condition was 51.32, while the mean for the word processing condition was lowest , 33.89 words. However, there were no significant differences in the amount of notes produced in the three conditions. A two-way analysis of variance showed significant differences ($p < .05$) between the groups in number of words of notes taken, but the differences between conditions were short of significant ($p < .10$).

Nor were there differences within the "both" condition. As shown in Table 5, of the thirteen writers taking notes in this condition, nine took notes with pen only, four took notes with word processing only, and two took notes with both. The number of words of notes taken with each media in the "both" condition were tallied and totalled. The means were similar: 27.42 words of notes taken with pen in the "both" condition, and 23.89 words taken with word processing. A *t*-test revealed no significant differences between the number of words of notes taken with pen and paper and the number taken with word processing in the "both" condition.
We had anticipated that writers would choose pen and paper for notes when it was available, and that they would produce significantly more notes with the pen and paper medium than when using the word processor for notes. However, our expectations about note-taking were not confirmed. While more writers used pen and paper to take notes, and while the number of words of notes was highest in the pen and paper condition, the only significant differences were between the two groups of writers.

In the course of this analysis, however, we observed that several of the writers in this study often produced, in their "notes" file, sentences and phrases or even blocks of text which then appeared, intact, in the final text. One student writer set up a "notes" file, but then started producing lines of text, which he later simply "cut and pasted" into his text window. This behavior bears similarities to novice writers studied by Bereiter and Scardamalia (1987a). These young writers produced lines of text in lieu of notes even when prompted to take notes only. Further, even writers who regularly take notes with word processing report being "drawn into text production;" i.e., the creation of gist-like or chunked notes seems to be difficult on-line

and they often produce phrases or even sentences of written text instead (H. Schwarz, personal communication, September, 1987). Further analysis might examine the notes produced by these writers in a more detailed way to determine if notes produced on-line are in fact more "text-like" than "note-like." In addition, subsequent research could examine the number of idea units present in the notes produced in each condition, explore the size of notes (whether the notes consisted of words, phrases, or sentences), or compare the amount of graphic notes (arrows, stars, boxes) produced with each tool.

Discussion and Implications

Result 1: There was less planning with word processing. Writers planned significantly less when they were using word processing than when they were using pen and paper. There were also significant differences in the proportion of planning that occurred before writers began to produce text. These results add credence to anecdotal reports of writers who feel pressed to begin writing sooner when using word processing, or who feel they "just can't sit and think" with their fingers on the keyboard (Bridwell-Bowles et al., 1987; Haas, 1987). Further, these results provide an interesting possible explanation of the "text sense" problem reported by some writers who use word processing (Haas & Hayes, 1986): if a writer plans less when producing a text with word processing, then the writer may experience a difficulty in "knowing" or recalling that text.

This study strongly suggests that amount of planning is decreased with word processing, and although it is not clear what caused these results, there are several possible reasons for less planning--and less initial planning--with word processing. While the amount and proportion of planning was less in the word processing condition, the writing sessions, protocols, and texts from this condition were not generally shorter. Possibly writers "make up for" repressed planning with word processing in other ways. In a pilot study, we found that while writers planned less in word processing conditions, they reread their texts more extensively than they

did in the pen and paper condition. Further research might explore the relationship between planning and other activities, such as rereading and evaluating.

Another reason that writers may plan less with word processing may have to do with the physical context in which some writers, particularly students, use word processing. Some students report that when working on public machines in terminal rooms, they often feel pressured to work quickly and not waste time because there may be other students waiting to use the computer (Haas, in preparation). However, most of the experienced writers in this study had access to their own Andrew workstation, while most of the students had learned to use a computer at home, often in their own room. While we should not discount the importance of the environment in which writers use word processing, the pressure of a public workspace was probably not the main cause of repressed planning in this study.

Maybe writers begin writing sooner and spend less time planning because making changes is easier with word processing. Word processing is a "less expensive" medium in which to produce text than is pen and paper, since with the former a word or sentence or paragraph can be deleted or rewritten very easily. Possibly writers realize that their documents can be changed easily with word processing and so produce text more quickly, relying on later revisions to perfect their ideas. While this may be the case, numerous studies have failed to consistently support claims of increased revision with word processing.

Further research should explore not only reasons for less planning with word processing, but also the impact of this decreased planning. Although most researchers agree that in general better writers plan more, the relationship of planning to text quality has not been established. It is not clear, for instance, if the differences in planning evidenced here would result in texts of lower judged quality.

Result 2: There was less conceptual planning and more sequential planning with word processing. Again, these results bear out reports of many writers and researchers that word

processing encourages an over-attendance to low level concerns, "tidying up" and "fiddling" at a local word or sentence level (Bridwell-Bowles et al., 1987; Case, 1985). Most researchers of planning in writing place particular value on high-level (conceptual) planning (Bereiter & Scardamalia, 1982, 1987a; Durst, 1987; Flower & Hayes, 1981c; Hayes & Flower, 1980). In addition, more able writers seem to be able to plan at higher, conceptual levels (Burtis et al., 1983; Flower & Hayes, 1981a, 1981b). However, most of these earlier studies have not gone on to conclusively relate high-level planning to text quality. Neither can we draw conclusions about the relationship of level of planning and text quality in this study; however, these results do strongly suggest that the use of word processing may have a profound influence on the level at which writers plan for writing.

Exactly why the word processor encourages this attention to local concerns is not clear. Certainly word processing makes local word and sentence level changes very easy. There are few word processing programs which support and encourage an attention to large scale text issues, and in fact the limited view of one's text offered by most word processing systems may actually discourage attending to the whole text. Since it is difficult to see one's whole document with word processing, writers may attend to what they can see on the screen. Another factor contributing to the decrease in conceptual planning with word processing may have been that the initial planning periods were shorter; it may be that much of the conceptual planning that writers do--forming arguments and theses, determining structure, organization, form--occurs during these initial planning periods.

Result 3: The effects of writing media were similar for both groups--experienced writers and student writers. One of the more interesting findings of this study was a lack of subject by condition interactions; that is, while some analyses showed the experienced writers planning significantly more (specifically, in total number of planning clauses), the effect of the word processing condition to repress planning in general, decrease initial and conceptual planning, and increase sequential planning was the same for each group. If the differences between the

word processing conditions and the pen and paper condition were due to subjects' greater familiarity with pen and paper, we might expect to see fewer differences between conditions for the experienced writers, who were also more experienced with both computers in general and with this word processing program. However, this was not the case.

While experience with word processing can be an important factor in how, and how well, writers use the technology, it may be naive to think that writers' concerns about the drawbacks of word processing and their continued use of pen and paper are simply a function of experience with the technology. The similar results for each group in this study certainly offer no support for this notion.

Result 4: There were vast differences in how writers use word processing and pen and paper together in the "both" condition. Maybe the most intriguing results of this study concern the way that writers responded to the "both" condition, the condition which allowed writers to use both word processing and pen and paper if they wished. These results are intriguing because they are so murky. The responses to this condition ranged from several writers who did not use pen and paper at all in this condition to one writer who wrote out her entire text in pen first, and then typed it into the machine. Interestingly, although several of the writers chose not to use pen and paper at all in this condition, none of them chose to work without the word processor.

Although the writers' responses to this "both" condition were vastly different, we are also unable to determine what effect, if any, there are for using the tools in different ways. Several subsequent analyses did not turn up any clear conclusions about the differences within this condition. Clearly, the way that writers use the two tools together is a rich area for further research. Subsequent studies might explore how writers actually use word processing and pen and paper together, the consequences of different patterns of use, and how factors like task variables and writing context can influence the ways that writers use the two tools.

In spite of what we still do not know about planning and word processing, these results do

suggest caution for educators about the use of word processing in the classroom. The results reported here could dishearten many teachers who may have hoped that word processing would diminish rather than exacerbate their students writing problems, allowing then to plan more extensively and to focus on higher level text concerns rather than local ones (Daiute, 1986).

However, these results suggest an opposite effect and should remind us again that there are no panaceas for writing difficulties, no high-tech solutions to the very real and complex problems of writing and learning to write. This is not to suggest that writers would be better off without word processing. Clearly, the word processor is an important and valuable tool for writers, one that is on our desks and in our classroom to stay. And with good reason: computer technology provides support for writing in any number of ways, from surface editing without recopying to electronic networks which may allow easier and more fruitful collaboration among writers. Further, more sophisticated computer-based writing supports may alleviate or diminish some of the problems of word processing. However, only by understanding both the benefits *and* the drawbacks of a writing medium or tool can we learn to improve it.

Finally, this study suggests that writers may be influenced in important and interesting ways by factors in their environments--including available writing technologies. Technological contexts--like social contexts--may have a powerful role in shaping writers cognitive processes, a role we are only beginning to understand.

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